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REMARKS

Status of the Claims

Claims 1-15 were examined and remain in the application. No additional claims are added. Only claim 1 is presently further amended. The amendment is to clarify the structure so as to put claim 1 in better condition for allowance. The amendment to claim 1 is not new matter, as it is taken from the general disclosure and, as previously amended, from page 3, lines 19 to 21 of the published priority document WO 2005/031250.

Reconsideration of the claims is requested for the very pertinent reasons set out below.

Record of Telephone Interview With Examiner

The Examiner's courtesy in granting a telephone interview is gratefully acknowledged. Per telephone interview with Examiner Vincent Q. Nguyen on 9/04/2007 and 9/05/2007, the undersigned sought clarification of the Office action of 8/09/2007 because it appeared to the undersigned to be an error to reject claims 1 to 5, 7, 8, 10, 14 and 15 under Section 102(b) in Paragraph 2 of the action when in fact Examiner cited a combination of references in such rejection. During the telephone interview, Examiner confirmed that because of typographical error, the rejection set forth in Paragraph 2 was intended as a Section 103 rejection. The undersigned asked for replacement of the Office action and resetting of the date for response. Examiner on 9/05/2007 said that he declined

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to reset the date or replace the Office action as Applicant was able to respond. The undersigned representative also emphasized claimed features relative to Lawrence but agreement was not reached on allowability of any claims.

Summary of the Rejections

The Examiner rejected claims 1 to 5, 7, 8, 10, 14 and 15 as lacking novelty under Section 102(b) over US 5,760,593 (Lawrence et al.) ["Lawrence"] in view of US 6465,271 (Ko et al.) ["Ko"] but Examiner pointed out in the telephone interview that this was intended as a Section 103 rejection. Applicant responds on the basis that Paragraph 2 was intended by Examiner to be a Section 103 rejection.

Claims 6, 9, 11 to 13 were treated as obvious over the combination of US 5,760,593 (Lawrence et al.) and US 5,973,502 (Bailleul et al.) ["Bailleul"].

Applicant directs comments primarily to claim 1 on the basis that, because this claim recites a combination of features which is both new and non-obvious, claim 1 is not only unanticipated by Lawrence but clearly patentably unobvious over Lawrence as combined with Ko.

Claims 2-15 are believed also to be allowable for same reasons as directly or indirectly dependent from claim 1.

Novel and Unobvious Features of Claim 1

Applicant asks that Examiner take a much more careful consideration of Lawrence et al. as it is believed that Examiner may have misunderstood the disclosure of the Lawrence reference. It is easy to so misunderstand this reference because of different embodiments taught therein. Examiner must take note of the fact that the Lawrence patent fails to disclose a shield made of *electrically conductive ceramic material*. In other words, the sensor assembly of the Lawrence reference, while containing no bulk metal parts, does in fact have a metal shield. It would appear to Applicant that Examiner is clearly still convinced that the sensor assembly of US 5760593 (Lawrence et al.) has an electrode and shield "*formed entirely from an electrically conductive ceramic (Col. 3 lines 12-16*" (paragraph 2 of the second Office Action). But that is not a correct interpretation of Lawrence. Therefore, we will herein discuss the Lawrence et al. patent in a systematic manner in order to simplify and aid understanding. We herein offer a detailed commentary on passages of Lawrence that relates specifically to the shield because what the Lawrence reference teaches to the skilled artisan must be further considered and appreciated.

First, it is necessary to see that for the Lawrence shield to provide its technical function of shielding or screening the electrode (see column 1, lines 45 to 48 of the Lawrence et al.) it has to be made of an electrically

conductive material. In all conventional sensor assemblies, including the sensor assembly described in US 5760593 (Lawrence et al.), the shield is made of an electrically conductive metal. If the shield is to be made of a ceramic material as applicant claims, then it follows that the ceramic material must also be electrically conductive. The presently claimed sensor must be contrasted directly with the insulating layers of Lawrence that separate the shield from the electrode and the housing. These are often made of ceramic materials but must be electrically non-conductive to achieve their isolating function.

The Lawrence reference starts by describing a known sensor assembly (probe) for a turbine that can be used to measure the clearance between the tips of the turbine blades and the housing. The sensor assembly includes an electrode that couples capacitively with the turbine blade, a shield and a probe body. The shield is electrically isolated from the electrode and the probe body by respective insulating elements that are machined from ceramic in the form of rings. Such probes suffer from problems in manufacturing the electrode elements and the cost of the overall assembly. The Background Art section of the Lawrence patent provides no specific teaching about the shield material, but clearly it would be made of metal.

In its broadest sense, the Lawrence et al. invention as described in the Summary of the Invention section of the

Lawrence patent consists of a sensor assembly where the insulating layers inside and outside the shield are formed by deposition (column 1, lines 66 to column 2, lines 7). In other words, the sensor assembly is the same as the known sensor assembly described in the Background Art section but the insulating layers are formed by deposition as opposed to being machined from ceramic. This reduces manufacturing costs because the ceramic rings are replaced by deposited ceramic layers that are simple and inexpensive to form (column 2, lines 8 to 12). The deposited insulating layers can also be made much thinner than the ceramic rings and this increases the sensitivity of the sensor assembly and reduces its overall physical dimensions (column 2, lines 12 to 21).

The first description of the Lawrence shield occurs at column 2, lines 22 to 28. More particularly, the sensor assembly may include a shield as a "preformed part". In that case, the insulating layers can be deposited on the shield (i.e. on the inner surface of the shield and the outer surface of the shield). Since the Lawrence patent references has already described the technical and commercial advantages of replacing machined ceramic rings with deposited layers, it is difficult to see how the skilled reader might conclude that the "*preformed part*" of the shield is an electrically conductive ceramic ring. The skilled reader would naturally conclude instead that the shield is manufactured in the form of a metal ring to which the insulating layers can be deposited. The Lawrence

reference immediately confirms this by stating that "*Such a probe is thus formed entirely by machining parts from **metal** (the electrode, **the part(s) forming the shield** and the body (if any)) **rather than from ceramics**"* (emphasis added). [Column 2, lines 25-28]

Examiner must recognize that in the Lawrence reference, The electrode, shield and probe body of the sensor assembly are therefore clearly and unambiguously described as being machined from metal.

Alternatives are described in Lawrence at column 2, lines 29 to 46. In the first place, the insulating layer provided between the electrode and the shield can be deposited on the electrode instead of the shield.

In that case, the Lawrence shield itself may be deposited on the insulation. It is at this point in the Lawrence reference where considerable care must be taken by Examiner not to assume that simply because the shield is deposited it is also made of a ceramic material. That would be an unwarranted assumption. It is important to stress that metal layers are also laid down using known deposition techniques. Such techniques are found described by any Internet search. There is nothing in the Lawrence reference to suggest that the shield can be made of anything other than metal. The skilled reader of the Lawrence reference would understand that the shield must be formed of an electrically conductive material (see comments

above and column 34 to 39 that reminds the skilled reader of the purpose of the shield, namely the reduction or elimination of any capacitive coupling with other elements such as an engine casing or the like) and with this in mind, the skilled artisan would not be led by the reference to consider forming the shield from an insulating ceramic material. Instead, the skilled reader would simply take this passage of Lawrence to mean that a metal layer might be deposited on the insulating layer of ceramic material using a known deposition technique.

If the probe body taught by Lawrence is also formed as a deposited layer (in the same way as the shield since it is also made of metal) then the sensor assembly will be formed as a "*single, monolithic, item*" (column 2, line 43 of this reference) in the sense that each layer is deposited on the underlying layer to fabricate the sensor assembly as a single structure. This evidently removes any need to assemble the various component parts of the sensor assembly together in the construction disclosed by Lawrence.

The passage at column 2, line 47 to column 3, line 3 of the Lawrence reference further describes how such a sensor assembly is not subject to differential thermal expansion. This is questioned in more detail later in this response, but it is important at this point to note the following statement at column 2, lines 65-66, of the Lawrence reference: "*with the probe according to this*

invention, substantially the entire probe can be formed from the same material . . . ." (emphasis added). This clearly means that the sensor assembly of Lawrence et al. contains different materials and is not formed entirely from ceramic materials. In fact, since the physical dimensions of the electrode dominate the other component parts (inferred by the Lawrence drawings) then this statement might imply that the problems of delamination are avoided since the majority of the sensor assembly--i.e. the electrode, shield and probe body--is formed of metal while only the thin insulating layers are formed from a ceramic material. Problems of differential expansion and vibration shearing force are therefore apparently avoided in the construction of the reference because the ceramic rings are no longer a significant part of the overall sensor assembly and they are deposited as layers rather than being preformed.

The passage at Lawrence column 3, lines 4 to 24 relates mainly to the electrode. For many purposes the electrode may be formed *"from a solid body of metal"* (column 3, lines 4 and 5). However, states the reference, in a preferred aspect the electrode is formed *"as a ceramic body"* (column 3, line 9). The electrode may be rendered conductive by having a layer of conductive metal, for example metal, deposited on the ceramic (column 3, lines 12 to 14). Alternatively, it is stated in the reference, the ceramic body can be formed as a conductive ceramic/metal composite which to the skilled artisan indicates that metal

would be present. Such a composite would include metal, contrary to what is presently claimed.

There are several issues that need to be commented on here. First, the foregoing extracts from Lawrence constitute a teaching that the electrode may be made entirely of metal. Even in the case where it is formed as a ceramic material this would be an electrically non-conductive ceramic because of the need to render it conductive by providing a metal layer, as by the deposition described in the Lawrence reference. The metal layer can be "deposited" reinforcing the earlier Lawrence disclosure that metal layers can be applied using deposition techniques. In other words, a deposited layer of Lawrence does not have to be a ceramic. Finally, based on the disclosure of the Lawrence reference, the use of an electrically conductive ceramic material is not considered to be suitable material for the electrode *per se;* it is only described with reference to a conductive ceramic/metal composite.

In the preferred embodiment of Lawrence et al., the shield, insulating layers and the housing (probe body) are all formed by deposition (column 3, lines 8 to 12). Once again, this does not in any way imply to the skilled artisan that the shield should be formed from a ceramic material. The Lawrence teaching is that the shield would take the form of a metal layer that is deposited on the insulating layer as explained previously in Lawrence et al.

The skilled reader does not receive from Lawrence et al. or Ko et al. any teaching or suggestion that the shield can be formed from an electrically conductive ceramic as required by claim 1 of the present invention. The shield cannot be formed from the same ceramic material as the electrode because this is electrically non-conductive. From the Lawrence reference, there is simply no logic to making the "shield" as a deposited layer of ceramic and then rendering it conductive by depositing a further metal layer. The shield cannot be formed from an electrically conductive ceramic because this is only described in the context of a conductive ceramic/metal composite.

The probe that is formed according to this teaching of Lawrence contains "*no **bulk** metal parts*" (emphasis added) (column 3, line 17). Thus, it must by implication contain some metal parts including *inter alia* the shield. it is simply the case that the Lawrence reference does not disclose a sensor assembly that is formed entirely of ceramic materials.

The rest of columns 3 and 4 of Lawrence explain some of the deposition techniques that can be used to lay down the layers. The techniques include deposition in the condensed phase, vacuum deposition, sputtering and plasma deposition. It is worthwhile noting that in plasma deposition (which is the preferred technique) "*the component is spun in a vacuum while a ceramic or **metal***

*powder is sprayed through an arc or flame that flashes it into a plasma. As the plasma hits the cold spinning part, it condenses, forming a layer of ceramic or **metal**. Each layer of insulation or **metal** may be formed as a single layer only . . . ."* (emphasis added) (column 3, lines 41 to 46). Applicant submits that this must be considered clear evidence that any mention by Lawrence et al. of a deposited shield layer means a deposited metal layer.

Further evidence is provided by Lawrence at column 3, line 62 to column 4, line 5. This passage deals with a method of forming the sensor assembly and includes the step of "*depositing a layer of insulation over at least that part of the electrode that will be located in the casing, depositing a **layer of metal** over the insulation **to form a shield** . . . .*" (emphasis added). Moreover, "*this method of manufacture of the device **may be employed for forming any of the devices described above***" (emphasis added) (column 4, lines 4 and 5).

Turning finally to the Detailed Description section of the Lawrence reference, the sensor assembly shown in Fig. 1 has a shield that comprises "*a bottom guard 8 and a top guard 10, **each of which is also machined from steel***" (emphasis added) (column 5, lines 5 to 7). See also, column 5, lines 22 and 23, which states that "*the **metal** forming the **top guard*** [i.e. shield] *will be electrically insulated from both the electrode 4 and the turbine casing 2.*" (emphasis added)

The sensor assembly of Fig. 2 includes a "*0.3 mm thick layer 16 of **platinum/iridium*** [i.e. a metal layer] *(excluding the front face) which forms the **shield***" (emphasis added) (column 6, lines 5 and 6). Applicant believes that this metal layer is formed by deposition since the passage goes on to say that the "*probe has the advantage that only one element, the electrode 4, need be formed by machining*" (column 6, lines 12 and 13). Thus, this provides further showing that metal layers can be formed using standard deposition techniques.

The sensor assembly of Fig. 3 of the Lawrence patent has a bulk ceramic electrode on which a platinum/iridium layer is deposited by plasma deposition. The shield 16 is said to be formed as described above with reference to Fig. 2. In other words, the shield of Fig. 3 is also a platinum/iridium layer that is presumably also applied using plasma deposition. The probe has no bulk metal parts, but clearly still includes a metal layer on the ceramic electrode and the shield.

Thus, in summary, it will be clear to the skilled reader that Lawrence et al. 5,760,593 only discloses a sensor assembly having a metal shield that is either preformed or deposited as a layer using deposition techniques. There is nothing in Lawrence et al. to suggest to the skilled artisan that the shield can be made of anything other than a construction including metal.

In that regard, if Examiner contends otherwise, it would be appropriate for Examiner to point specifically to the passage or passages of Lawrence that he thinks describe how the shield can be formed of an electrically conductive ceramic material.

Examiner is asked to recognize that Lawrence is directed to a sensor assembly where the insulating layers are deposited rather than machined. Applicant respectfully contends there is nothing in the art cited, whether Lawrence et al. or Ko et al. to teach or suggest that any further technical advantage might be achieved by eliminating metal layers completely as according to the presently claimed sensor for capacitively measuring the distance to a stationary or passing object. Instead, satisfactory results are said in the Lawrence reference to be achieved solely by a sensor assembly having no "bulk metal parts," that is, where the majority of the sensor assembly is ceramic but where the shield and in some cases the conductive layer provided on the front surface of the electrode are metal.

Applicant, Mr. Elliott, has discovered that sensor assemblies made in accordance with the prior art, as in Lawrence et al., continue to suffer from serious technical problems because of the alternating combination of metal and ceramic materials. In particular, the ceramic layers may delaminate from the metal shield which causes the

sensor assembly to fail electrically and in some cases results in mechanical failure (see the Background Art section of the present application). The solution, as presently disclosed, is to eliminate metal completely by using alternating layers of electrically conductive and electrically non-conductive ceramic materials whose coefficients of thermal expansion are specifically selected to be similar.

It is of extreme importance that Examiner should appreciate that the deposited shield layers of Lawrence et al. are formed by one or more layers of metal, whereas the deposited insulating layers are formed by one or more deposited layers of electrically non-conducting ceramic material. In other words, the mere fact that shield layers can also be deposited does not imply, and certainly does not suggest, to the skilled artisan that these layers are also formed from an electrically conductive ceramic material.

The presently claimed construction, as set forth in claim 1, provides the advantageous characteristic feature that the sensor assembly remains virtually stress free at high operating temperatures. This is not the case for known sensor assemblies such as those described in Lawrence et al. where delamination allows the shield to vibrate during use and can eventually result in the mechanical failure of the complete sensor assembly. The sensor of the presently claimed invention, as set forth in claim 1, overcomes the problems

caused by stress in a completely new way, namely by eliminating metal parts (not just bulk metal parts) so that the sensor assembly is formed entirely of ceramic materials. That is, the electrode [2, 102] and the shield [105] are formed entirely from an electrically conductive ceramic material and the insulating layer [104] and the housing [4, 106] are formed entirely from an electrically non-conductive ceramic material such that the sensor assembly is formed entirely from ceramic materials. These claimed features are contrary to the teachings of Lawrence et al. and not suggested by the Lawrence reference. Moreover, the electrically conductive and non-conductive ceramic materials are selected to have substantially similar thermal expansion coefficients so that the sensor remains virtually stress free at high operating temperatures, as emphasized in the above-referenced additional limitation in claim 1. Therefore, even if the skilled person did look to modify the sensor of Lawrence et al. to replace all the metal parts, it is not obvious to substantially match the thermal expansion coefficients of the conductive and non-conductive ceramic materials to arrive at a sensor that falls within the scope of claim 1.

When the Lawrence et al. disclosure is considered as a whole, the skilled person is effectively told to accept that there will be some differential thermal expansion but that this can be minimized to levels where it will not cause any practical problems because of the lack of bulk metal parts. The skilled artisan would understand readily that the thermal properties of the metal and ceramic

material that are used in the sensor of Lawrence et al. do not even come close to being matched. By way of example only, the average thermal expansion coefficient of platinum/iridium (i.e. a deposited metal layer) is $8.7 \times 10^{-6}\ K^{-1}$, whereas the average thermal expansion of aluminum nitride (i.e., a deposited insulating layer) is $4.5 \times 10^{-6}\ K^{-1}$.

Therefore, even if the skilled person did look to modify the sensor of Lawrence et al. to replace all the metal parts, it is not obvious to substantially match the thermal expansion coefficients of the conductive and non-conductive ceramic materials to arrive at a sensor that falls within the scope of claim 1. That is not to say, however, that the matching of the thermal expansion coefficients is just a natural consequence of the use of ceramic material throughout the sensor. There are many different types of electrical conductive and non-conductive ceramic materials that would be suitable for use in the sensor. It is therefore not just a simple task of selecting conductive and non-conductive ceramic materials at random and assuming that their respective thermal expansion coefficients will be substantially similar. However, once a proper selection is made then the sensor of the present invention has a much longer operating time and can be used at higher temperatures than conventional sensors in that the sensor assembly remains virtually stress free at high operating temperatures. In paragraph 2 of the Office action the Examiner seems to suggest that a

disclosure for matching the thermal expansion coefficients can be found at column 3, lines 25 to 61 of Lawrence et al. But that is not so. This paragraph of Lawrence et al. relates to the various methods that are available for deposition (i.e. deposition in the condensed phase or vacuum, chemical and plasma deposition) and the options for having one or more layers. Insulating layers are generally oxides and nitrides of metals of metalloids such as oxides and nitrides of aluminum, titanium, tantalum and silicon. There is nothing here in Lawrence et al. to suggest the improvement of choosing the composition of the insulating and shield layers to have substantially similar thermal expansion coefficients.

Ko et al. seems not at all relevant to Applicant's claim 1. The all-silicon capacitive sensor of Ko et al. is made of silicon, not ceramic, and it is not designed or useful for measuring distance, but instead is pressure responsive. The only mention of ceramic is found at column 3, lines 18-21 of the Ko reference, where it is stated "The TMCPS diaphragm can be made of different materials, such as silicon, poly-silicon, silicon nitride, polymeric materials, metal, and metallized ceramic." That has to do only with the so-called TMCPS diaphragm rather than the entire Ko sensor. So also, metallized ceramic (as taught by Lawrence et al.) is precisely a teaching in the opposite direction from the disclosure and claims of the present applicant. The Ko teaching of method for forming an electrical feedthrough to a conductor in a cavity has no

relation at all to the presently claimed sensor set forth in claim 1. Therefore, the addition of Ko et al. to Lawrence et al. in the rejection of claim 1 is not understood, and should be withdrawn.

In view of these precise points, Examiner is asked to reconsider claim 1, as amended, in light of the Lawrence et al. reference, for it sets forth a combination which Lawrence et al. or the Lawrence reference combined with Ko et al. has neither taught nor suggested. Claim 1 is not anticipated by Lawrence et al. and is patentably unobvious thereover.

Claim 1 should accordingly be held allowable.

Claims 2-15 are believed also be allowable for same reasons as being dependent from claim 1 either directly or indirectly.

It is again noted that claims 6, 9, 11 to 13 have been rejected as being obvious, according to Examiner, over the combination of US 5,760,593 (Lawrence et al.) and US 5,973,502 (Bailleul et al.). Bailleul et al. has been reviewed but is not believed to remedy the deficiency of Lawrence et al., which for the reasons detailed above, has failed to anticipate or render obvious the combination set forth in claim 1.

Accordingly, very careful reconsideration of claims is warranted and is requested.

The amendments herein are in the nature of clarifying amendments and further emphasize and contrast the novel structure of applicant's invention relative to the prior art. The entry of these amendments requires no new search, raises no new issue and requires no substantial amount of additional work by the Patent and Trademark Office. The entry of these amendments is necessary and proper inasmuch as they are believed to place the application in form for allowance or certainly in better form for appeal (if for any reason the claims as amended are not found allowable).

These amendments could not have been presented earlier, inasmuch as the issues, interpretation, or rationale for the rejections has not been fully developed before the most recent Office action.

In view of the foregoing, withdrawal of the final rejection, entry of this amendment, and a formal notice of allowance are requested. If for any reason the application is not held to be allowable, entry of this amendment for the purpose of appeal is hereby requested.

If Examiner intends to take any action other than allowance, or if any issue could be readily resolved or other action could be taken to advance this application,

such as Examiner's amendment, it is requested that Examiner please telephone the undersigned.

It is believed that the foregoing resolves all remaining issues, and the application is in good order for allowance, and a Notice of Allowance is solicited. The undersigned looks forward to working with Examiner to resolve any remaining issues in the application. If Examiner has any questions or believes there is any remaining issue, which could be readily resolved or other action could be taken to advance this application, such as by Examiner's amendment or interview by telephone or in person, it is requested that Examiner please telephone or e-mail the undersigned representative to arrange telephone interview, and the undersigned will gladly cooperate to advance the prosecution.

Respectfully submitted,

4 October 2007
Date

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